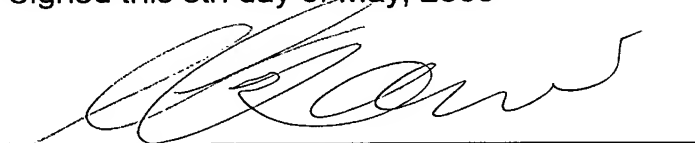




I, Kumiko Kawai of Tranomon East Building, 7-13, Nishi-Shimbashi 1-chome, Minato-ku, Tokyo 105-8408, Japan, hereby declare that I am conversant with the Japanese and the English languages and that I am the translator of the document attached and certify that to the best of my knowledge and belief the following is a true and correct English translation of the specification contained in the Japanese Patent Application No. 2002-314904.

Signed this 8th day of May, 2006



Kumiko Kawai

Patent Department



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[Title of the Invention]

Magnifying observation apparatus, a method for operating the magnifying observation apparatus, a program for operating the magnifying observation apparatus, and a computer-readable recording medium

[Claims]

1. Magnifying observation apparatus comprising imaging means for photographing an observed image and display means for displaying the observed image based on a signal acquired with said imaging means, said magnifying observation apparatus further comprising:

simple observation condition setting means for setting simple observation conditions for simply acquiring a plurality of observed images;

simple observed image display means for displaying a plurality of simple observed images acquired per said plurality of simple observation conditions set with said simple observation condition setting means;

selection means for selecting a desired simple observed image from among the plurality of simple observed images displayed on said simple observed image display means; observation condition setting means for setting further observation conditions as required based on the simple observation conditions set to the simple observed image selected with said selection means; and

observed image display means for displaying an observed image

acquired based on the observation conditions set with said observation condition setting means.

2. Magnifying observation apparatus comprising imaging means for photographing an observed image and display means for displaying the observed image based on a signal acquired with said imaging means, said magnifying observation apparatus further comprising:

simple observation condition setting means for setting simple observation conditions for simply acquiring a plurality of observed images;

simple observed image acquisition means for acquiring simple observed images acquired per said plurality of simple observation conditions set with said simple observation condition setting means;

simple observed image storage means for storing a plurality of simple observed images acquired with said simple observed image acquisition means;

simple observed image display means for displaying a plurality of simple observed images stored into said simple observed image display means;

selection means for selecting a desired simple observed image from among the plurality of simple observed images displayed on said simple observed image display means; observation condition setting means for setting further observation conditions as required based on the simple observation conditions set to the simple observed image selected with said selection means;

observed image acquisition means for acquiring an observed

image based on the observation conditions set with said observation condition setting means; and

observed image display means for displaying an observed image acquired with said observed image acquisition means.

3. Magnifying observation apparatus according to claim 1 or 2, characterized in that said simple observed image display means tiles a plurality of simple observed images.

4. Magnifying observation apparatus according to claim 1 or 2, characterized in that said simple observed image display means comprises switching means for selectively displaying the plurality of simple observed images.

5. Magnifying observation apparatus according to anyone of claims 1 through 4, characterized in that said magnifying observation apparatus comprises adjustment means for performing at least positioning and focusing on an observed image displayed on said observed image display means before setting simple observation conditions on said simple observation condition setting means.

6. Magnifying observation apparatus according to anyone of claims 1 through 5, characterized in that the simple observation conditions set with said simple observation condition setting means includes any one of the control of brightness of an image, adjustment of illumination method, adjustment of the angle of the imaging means, and image processing.

7. Magnifying observation apparatus according to claim 6, characterized in that said adjustment of the illumination method

is made by way of at least selection between incident-light illumination and transmitting illumination, selection between peripheral illumination and side illumination as an illumination direction, or diffusion means, polarization means or a transmitted light without using filters as a filter for an illumination light.

8. Magnifying observation apparatus according to claim 6 or 7, characterized in that said control of the brightness of an image is done by way of at least one of the control of the light quantity of the illumination, adjustment of the shutter speed of the imaging means, gain control, and control of white balance.

9. Magnifying observation apparatus according to anyone of claims 1 through 8, characterized in that at least the characteristics of an observation subject can be set with said simple observation condition setting means.

10. A method for operating the magnifying apparatus which photographs and displays an observed image, said method comprising:

- a step of performing at least positioning and focusing on an arbitrary observed image displayed;

- a step of varying the observation conditions and setting simple observation conditions for simply acquiring a plurality of observed images on the adjusted observed image;

- a step of acquiring simple observed images per said plurality of simple observation conditions set;

- a step of tiling on simple observed image display means the plurality of simple observed images acquired;

a step of selecting a desired simple observed image from among the plurality of simple observed images displayed on said simple observed image display means;

a step of setting further observation conditions as required based on the simple observation conditions set to the simple observed image selected with said selection means;

a step of acquiring an observed image based on the observation conditions; and

a step of displaying the acquired observed image.

11. A program for operating the magnifying observation apparatus which photographs and displays an observed image, said program causing a computer to serve as:

adjustment means for performing at least positioning and focusing on an arbitrary observed image displayed; simple observation condition setting means for varying the observation conditions and setting simple observation conditions for simply acquiring a plurality of observed images on the adjusted observed image;

simple observed image acquisition means for acquiring simple observed images per said plurality of simple observation conditions set with said simple observation condition setting means;

simple observed image display means for tiling the plurality of simple observed images acquired with said simple observed image acquisition means;

selection means for selecting a desired simple observed image



from among the plurality of simple observed images displayed on said simple observed image display means; observation condition setting means for setting further observation conditions as required based on the simple observation conditions set to the simple observed image selected with said selection means;

observed image acquisition means for acquiring an observed image based on the observation conditions set with said observation condition setting means; and

observed image display means for displaying an observed image acquired with said observed image acquisition means.

12. A computer-readable recording medium which stores the program for operating the magnifying observation apparatus according to claim 11.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

The present invention relates to magnifying observation apparatus for photographing and displaying a magnified image such as a microscope, a method for observing a magnified image, a program for operating the magnifying observation apparatus, and a computer-readable recording medium.

[0002]

[Prior Art]

Today, optical microscopes and digital microscopes are in use as magnifying observation apparatus which display magnified

micro-objects. A microscope is equipped with a photoreceptor device such as a CCD for electrically reading, per pixel arranged two-dimensionally, a reflected light or a transmitted light from an observation subject fixed to the observation subject fixing section incident via an optical system. The microscope displays on the display section such as a display an image electrically read using a CCD (for example see the Japanese Patent Laid-Open No. 2000-214790).

[0003]

When observing a subject (work) such as an observation subject, it is necessary to adjust the observation conditions optimally in order to obtain a desired image. Setting items of observation conditions include the illumination method, brightness and angle. Typically, the user who operates a microscope manually replaces the illumination parts of the lens, controls the brightness of the illumination, or switches between illumination methods to check the effect of control while displaying the observed image on the monitor on a trial-and-error basis, thereby searching for observation conditions optimum for the work.

[0004]

[Patent Document 1]

Japanese Patent Laid-Open No. 2000-214790

[0005]

[Problems that the Invention is to Solve]

However, the method where the optimum observation conditions are searched for on a trial-and-error basis is highly cumbersome

and time-consuming. Typically, only a single image can be displayed on the monitor. Thus, the required procedure is: 1) an observed image is displayed with certain observations specified; 2) the observed image is evaluated; 3) the optimum observation conditions are specified; and 4) the observed image is displayed again. In this case, the observed image on the previous occasion is not stored so that the user must rely on his/her memory to predict more appropriate observation conditions based on comparison between the current observed image and the previous observed image. This procedure is repeated. The user predicts further optimum observation conditions based on his/her memory of the relationship between the parameters of the previous and second previous observation conditions and the images as well as states of changes. This makes the procedure extremely difficult. Moreover, the user needs expert knowledge on the performance of apparatus, photographing method, and meanings of parameters of the setting items in order to set the observation conditions. Thus the above procedure is too difficult especially for a beginner. Accordingly, only the user having some degree of knowledge and experience can obtain the optimum observation results. Sufficient results cannot be obtained with insufficient observation conditions even when the performance of the microscope is excellent. Under present circumstances, the performance of the microscope used is not fully delivered in most cases.

[0006]

The invention has been accomplished in view of the

aforementioned circumstances and mainly aims at providing magnifying observation apparatus which facilitates setting of observation conditions thereby improving the usability.

[0007]

[Means for Solving the Problems]

In order to attain the object, the invention provides, in its first aspect, magnifying observation apparatus comprising imaging means for photographing an observed image and display means for displaying the observed image based on a signal acquired with the imaging means, the magnifying observation apparatus further comprising: simple observation condition setting means for setting simple observation conditions for simply acquiring a plurality of observed images; simple observed image display means for displaying a plurality of simple observed images acquired per the plurality of simple observation conditions set with the simple observation condition setting means; selection means for selecting a desired simple observed image from among the plurality of simple observed images displayed on the simple observed image display means; observation condition setting means for setting further observation conditions as required based on the simple observation conditions set to the simple observed image selected with the selection means; and observed image display means for displaying an observed image acquired based on the observation conditions set with the observation condition setting means.

[0008]

The observation condition setting means may be setting means which can further adjust the conditions set with the simple observation condition setting means. The simple observation condition setting means and the observation condition setting means may be provided by way of a same user interface screen.

[0009]

The invention provides, in its second aspect, magnifying observation apparatus comprising imaging means for photographing an observed image and display means for displaying the observed image based on a signal acquired with the imaging means, the magnifying observation apparatus further comprising: simple observation condition setting means for setting simple observation conditions for simply acquiring a plurality of observed images; simple observed image acquisition means for acquiring simple observed images acquired per the plurality of simple observation conditions set with the simple observation condition setting means; simple observed image storage means for storing a plurality of simple observed images acquired with the simple observed image acquisition means; simple observed image display means for displaying a plurality of simple observed images stored into the simple observed image display means; selection means for selecting a desired simple observed image from among the plurality of simple observed images displayed on the simple observed image display means; observation condition setting means for setting further observation conditions as required based on the simple observation conditions set to the simple observed image selected

with the selection means; observed image acquisition means for acquiring an observed image based on the observation conditions set with the observation condition setting means; and observed image display means for displaying an observed image acquired with the observed image acquisition means.

[0010]

The simple observed image acquisition means is means for simply acquiring an observed image and acquires an observed image for example by increasing the frame scan speed than typical image observation. A simple observed image may be acquired using the same method for acquiring a typical observed image.

[0011]

The invention provides, in its third aspect, magnifying observation apparatus according to the first or second aspect, characterized in that the simple observed image display means tiles a plurality of simple observed images.

[0012]

The invention provides, in its fourth aspect, magnifying observation apparatus according to the first or second aspect, characterized in that the simple observed image display means comprises switching means for selectively displaying the plurality of simple observed images.

[0013]

The display means can selectively display observed image display means and the simple observed image display means. Switchover

between these two display screens can be made by way of a dedicated button on the magnifying observation apparatus or an operation program incorporated into the main unit.

[0014]

The invention provides, in its fifth aspect, magnifying observation apparatus according to any one of the first through fourth aspects, characterized in that the magnifying observation apparatus comprises adjustment means for performing at least positioning and focusing on an observed image displayed on the observed image display means before setting simple observation conditions on the simple observation condition setting means.

[0015]

The invention provides, in its sixth aspect, magnifying observation apparatus according to any one of the first through fifth aspects, characterized in that the simple observation conditions set with the simple observation condition setting means includes any one of the control of brightness of an image, adjustment of illumination method, adjustment of the angle of the imaging means, and image processing.

[0016]

The invention provides, in its seventh aspect, magnifying observation apparatus according to the sixth aspect, characterized in that the adjustment of the illumination method is made by way of at least selection between incident-light illumination and transmitting illumination, selection between peripheral

illumination and side illumination as an illumination direction, or diffusion means, polarization means or a transmitted light without using filters as a filter for an illumination light.

[0017]

Further, the invention provides, in its eighth aspect, magnifying observation apparatus according to the sixth or seventh aspect, characterized in that the control of the brightness of an image is done by way of at least one of the control of the light quantity of the illumination, adjustment of the shutter speed of the imaging means, gain control, and control of white balance.

[0018]

Moreover, the invention provides, in its ninth aspect, magnifying observation apparatus according to any one of the first through eighth aspects, characterized in that at least the characteristics of an observation subject can be set with the simple observation condition setting means.

[0019]

The invention provides, in its tenth aspect, a method for operating the magnifying apparatus which photographs and displays an observed image, the method comprising: a step of performing at least positioning and focusing on an arbitrary observed image displayed; a step of varying the observation conditions and setting simple observation conditions for simply acquiring a plurality of observed images on the adjusted observed image; a step of acquiring simple observed images per the plurality of simple observation



conditions set; a step of tiling on simple observed image display means the plurality of simple observed images acquired; a step of selecting a desired simple observed image from among the plurality of simple observed images displayed on the simple observed image display means; a step of setting further observation conditions as required based on the simple observation conditions set to the simple observed image selected with the selection means; a step of acquiring an observed image based on the observation conditions; and a step of displaying the acquired observed image.

[0020]

The invention provides, in its eleventh aspect, a program for operating the magnifying observation apparatus which photographs and displays an observed image, the program causing a computer to serve as:

adjustment means for performing at least positioning and focusing on an arbitrary observed image displayed; simple observation condition setting means for varying the observation conditions and setting simple observation conditions for simply acquiring a plurality of observed images on the adjusted observed image; simple observed image acquisition means for acquiring simple observed images per the plurality of simple observation conditions set with the simple observation condition setting means; simple observed image display means for tiling the plurality of simple observed images acquired with the simple observed image acquisition means; selection means for selecting a desired simple observed image from among the plurality

of simple observed images displayed on the simple observed image display means; observation condition setting means for setting further observation conditions as required based on the simple observation conditions set to the simple observed image selected with the selection means; observed image acquisition means for acquiring an observed image based on the observation conditions set with the observation condition setting means; and observed image display means for displaying an observed image acquired with the observed image acquisition means.

[0021]

Further, the invention provides, in its twelfth aspect, a computer-readable recording medium which stores the program for operating the magnifying observation apparatus according to the eleventh aspect.

[0022]

The recoding media include magnetic disks, optical discs, magneto-optical disks, and other media such as semiconductor memories which can store programs.

[0023]

[Mode for Carrying Out the Invention]

Embodiments of the invention will be described referring to the drawings. The following embodiments illustrate magnifying observation apparatus, a method for operating the magnifying observation apparatus, a program for operating the magnifying observation apparatus, and a computer-readable recording medium used

to embody the technical thoughts of the invention. Note that the invention is not limited to the following magnifying observation apparatus, method for operating the magnifying observation apparatus, program for operating the magnifying observation apparatus, and computer-readable recording medium.

[0024]

The specification does not limit the members defined in the claims to those in the embodiments. The size of each member and relation between the members are exaggerated depending on the drawings for simplicity.

[0025]

Connection between magnifying observation apparatus used in the embodiment of the invention and a computer, printer, an external storage device and other peripherals for performing processing including operation, control, and display is made electrically, magnetically or optically to perform communications via, for example, serial connection such as IEEE1394, RS-232x and RS-422, and UBS, parallel connection, or a network such as 10BASE-T, 100BASE-TX, and 100BASE-T. The connection is not limited to a wired physical connection but may be a wireless LAN such as IEEE802.11x or wireless connection using radio waves, infrared rays or optical communications such as Bluetooth. A recording medium for exchanging data and saving the setting may be a memory card, a magnetic disk, an optical disc, a magneto-optical disk, and a semiconductor memory.

[0026]

The magnifying observation apparatus according to the embodiment of the invention will be described using Figs. 1 through 11. The magnifying observation apparatus comprises an illumination section 60 for illuminating an observation subject, an imaging section 10 for photographing the observation subject illuminated with the illumination section 60, and a display 52 for displaying a magnified image photographed with the imaging section 10.

[0027]

To be more specific, as shown in Fig. 2, the imaging device comprises an observation subject fixing section (stage 30 for mounting the observation subject S) and a photoreceptor device (CCD 12) for electrically reading per pixel arranged two-dimensionally a reflected light or a transmitted light from the observation subject fixed to the observation subject fixing section, the light incident via an optical system. Further, an information processor 50 (magnifying observation apparatus main unit) is connected to the imaging device. The information processor 50 comprises an image data storage (memory 53) for storing image data read by the photoreceptor device, a display 52 for displaying an image based on the image data electrically read by the photoreceptor device, and an input section (an operation section 55, a pointing device 55a) for performing input based on a screen displayed on the display 52, and a controller 51 for performing processing such as image processing base on the information input with the input section.

[0028]

Fig. 1 shows an external view of magnifying observation apparatus according to an embodiment of the invention. A camera 10 comprising an optical system and an image pick-up device is attached to a camera attaching section 43 fixed to a support extending vertically from a stand 41. On the stand 41 is arranged a stage elevator 20 on top of which is attached a stage 30 for placing an observation subject S. The camera 10 and the stage elevator 20 are connected to and controlled by the information processor 50. The information processor 50 comprises a display 52 and an operation section such as a pointing device 55a. An observed image display 52A and a simple observed image display 52B are alternately or simultaneously displayed on the display 52.

[0029]

Fig. 2 shows a block diagram of magnifying observation apparatus according to an embodiment of the invention. The information processor 50 comprises a display 52, a memory 53 for storing a control program, focal length information, light reception data and two-dimensional information, an interface 54 to communicate with the camera 10 and the stage elevator 20, and an operation section 55 used by the operator to perform operation concerning magnifying observation apparatus. The stage elevator 20 comprises, for example, a stepping motor 21 and a motor controller 22 for controlling elevation of the stepping motor 21. The camera 10 comprises, for example, a photoreceptor device such as a CCD 12, a CCD controller circuit 13 for performing drive control of the CCD 12, and an optical system

11 for forming on the CCD 12 an image of a reflected light of a light irradiated onto an observation subject S placed on the stage 30 from the illumination section 60.

[0030]

The information processor 50 inputs control data on the control of the stepping motor 21 into the motor control circuit 22 to vary the relative distance between the stage 30 as an observation subject fixing section and the camera 10 comprising the optical system 11 and the CCD 12 as a photoreceptor device in the optical axis direction, or height in the z direction in this example. In particular, the information processor 50 inputs control data necessary to control the stage elevator 20 into the motor control circuit 22 to control rotation of the stepping motor 21 and elevates/lowers the height z (position in the z direction) of the stage 30. The stepping motor 21 generates a rotation signal in accordance with the rotation. The information processor 50 stores the height z of the stage 30 as information on the relative distance between the observation subject fixing section 30 and the optical system 11 in the optical axis direction. While the relative distance between the observation subject fixing section 30 and the optical system 11 in the optical axis direction is varied by varying the height of the stage 30 in this embodiment, the stage 30 may be fixed and the height of the optical system 11, for example the height of the camera 10 may be varied.

[0031]

The CCD 12 can electrically read the quantity of photoreception per pixel arranged two-dimensionally. The image of the observation subject S formed on the CCD 12 is converted to an electrical signal in each pixel in accordance with the quantity of photoreception and converted to digital data in the CCD control circuit 13. The information processor 50 stores into a memory 53 the digital data from the CCD control circuit 13 as photoreception data D together with the pixel arrangement information (x, y) as the two-dimensional position information of an observation subject in a plane (x and y directions in Fig. 2) approximately perpendicular to the optical axis direction (z direction in Fig. 2). The plane approximately perpendicular to the optical axis direction need not be a plane strictly at a right angle from the optical axis but may be an observation plane within the range of inclination where the shape of the observation subject can be recognized at the resolution of the optical system and the photoreceptor device.

[0032]

While the observation subject is placed on the stage as an example of observation subject fixing section in the foregoing description, an arm may be attached instead of a stage and an observation subject may be fixed to the tip of the arm.

[0033]

The illumination section 60 shown in Fig. 1 comprises an incident-light illumination 60A for irradiating an incident light and a transmitting illumination 60B for irradiating a transmitted

light. These illuminations are connected to the information processor 50 via the optical fiber 61. The information processor 50 comprises a connector 62 for connecting the optical fiber 61 and incorporates a light source (not shown) for transmitting a light to the optical fiber 61 via the connector 62. The light source may be a halogen lamp.

[0034]

Fig. 3 is a general view of the terminal of an optical fiber 61 used to couple the optical fiber 61 connected to the illumination section 60 to the information processor 50 and a mask plate 63 for partially masking an illumination light delivered to the illumination section 60 between the terminal and a light source. Fig. 3A shows a plan view of the mask plate 63. Fig. 3B shows a sectional view of the mask plate 63. The mask plate 63 is incorporated in the information processor 50 and arranged between the terminal of the optical fiber 61 connected to the information processor 50 and the light source. As shown in Fig. 3A, the mask plate 63 has a shape of two large and small approximate fans and has a rotary axis 64 at the connection point. The large fan is provided with an opening 65, where are provided an opening 65A of an approximate circular shape for peripheral illumination and an opening 65B of an approximate fan for side illumination. On the small fan, a gear groove is formed in the lateral periphery. The mask plate 63 is rotatably linked about the rotary shaft 64 and is rotated by a motor 66. The motor 66 has a worm gear on its rotary shaft and is arranged so that the gear



section of the worm gear engages with the gear groove provided in the arc of the small fan of the mask plate 63. When the motor 66 is started to rotate the mask plate 63, either the opening 65A for peripheral illumination and the opening 65B for side illumination is aligned with one of the terminals of the two optical fibers 61. This connects one of the optical fibers 61 with the light source thus allowing a light to be illuminated from the illumination section 61.

[0035]

A mechanism to rotate the mask plate 63 is not limited to the worm gear configuration but may be a combination of a pinion gear and a plate gear, a configuration using a crank, or a direct rotation system using a stepping motor or a servo motor.

[0036]

The opening 65 wholly or partially opens one of the optical fibers 61. When any opening is aligned with one of the optical fibers 61, the other optical fiber 61 is completely blocked by the mask plate 63. As a result, either the incident-light illumination or side illumination is connected to the light source thus causing only either illumination to work exclusively.

[0037]

Fig. 4 shows the difference between the peripheral illumination and the side illumination. The illumination section 60 is a luminescent section arranged in a ring shape so as to radiate a light in accordance with the section of the optical fiber 61. A light

radiated from the ring-shaped luminescent section 60 onto an observation subject converges toward the central axis of the ring as it is radiated as shown in Fig. 4.

[0038]

When the opening 65A for peripheral illumination is aligned with the terminal of the optical fiber 61, light is supplied to all the section area of the optical fiber 61. Light is irradiated from all sections of the ring-shaped illumination section 60 as shown in Fig. 4A. As a result, peripheral illumination is provided where light is illuminated onto the observation subject from the periphery. When the opening for side illumination is aligned with the terminal of the optical fiber 61, light is supplied to only part of the section area of the optical fiber 61. The other parts are masked. As a result, side illumination is provided where light is partially irradiated as shown in Fig. 4B. In this example, the central angle of the fan of the opening for side illumination is approximately 90 degrees so that only about one fourth of the entire area of the ring-shaped illumination section 60 emits light thus irradiating only the lateral section.

[0039]

As shown in Fig. 4C, it is possible to use a filter such as a diffuser 67 or a polarizer 68 for peripheral illumination shown in Fig. 4A. The diffuser 67 suppresses the intensity of a light by diffusing the light thus radiating a soft light. The polarizer 68 has an effect of suppressing the glare of a reflected light. When

a light is caused to pass through one of these filters, respective light effect of the filter used is obtained. To insert a filter or change filters, a plurality of filters may be provided on a turret similar to the mask plate and the turret may be rotated to switch between the filters. Fig. 4D shows an example where a filter as the diffuser 67 or the polarizer 68 is used for side illumination shown in Fig. 4B.

[0040]

In this way, illumination methods applicable to an outgoing light from the ring-shaped illumination of the foregoing embodiment include the incident-light illumination and side illumination. For each of the incident-light illumination and side illumination, peripheral illumination or side illumination is applicable. Further, a diffuser, a polarizer or a transmitted light without using filters may be applied as filtering. A combination of these may be used to vary the illumination method. Setting of these conditions is made on the observation condition setting screen as observation condition setting means.

[0041]

Fig. 5 shows an illumination condition selection screen as an example of an observation condition setting screen. The screen is a user interface screen of a program for operating the magnifying observation apparatus used to operate the operating a magnifying observation apparatus and is displayed in the display section 52 of the magnifying observation apparatus. The program for operating

the magnifying observation apparatus is incorporated in the information processor 50 as a controller of the magnifying observation apparatus. From the screen, the user operates a pointing device such as a mouse as input means to select radio buttons and specify illumination conditions.

[0042]

[Input means]

The screens shown in Figs. 5 through 8 and Fig. 10 are setting screens for implementing a simple observed image acquisition feature. The procedure to implement the simple observed image acquisition feature will be described later with reference to the flowchart in Fig. 11. The input columns as well as the arrangement, shape, representation, size, color and pattern of each button may be varied as required. It is possible to provide an easier-to-see display which allows easy evaluation and judgment and an easy-to-operate layout by way of a change in the design of the screens. For example, a Wizard-based input in each item may be employed so that the user has only to answer questions to make necessary setting. While a detail setting screen is given as a separate window or a detail setting column is provided in the setting window in the following description, either approach may be used or both approaches may be used.

[0043]

In these user interface screens for the program, ON/OFF of virtual buttons and input columns and specification of a numerical values and instruction input are made on an input section connected

to an information processor incorporating the program for the magnifying observation apparatus or a computer where the program is installed. In this specification, the term "press" includes an operation of a button by way of physical contact and a simulated push by way of a click or selection on the input section. An input/output device is connected to the computer by wire or by radio, or fixed to the computer. General input sections include, for example, a mouse or a keyboard, and various pointing devices such as a slide pad, a track point, a tablet, a joystick, a consol, a jog dial, a digitizer, a light-pen, a ten-key pad, a touch pad, and an acupoint. These input/output devices may be used to operate hardware such as magnifying observation apparatus as well as operation of a program. Further, a touch screen or touch panel may be used as a display to provide an interface screen so that the user can directly touch the screen with his/her hand for input or operation. Alternately, voice input or any other existing input means or a combination of these may be used.

[0044]

A computer 70 may be connected to the magnifying observation apparatus. By separately installing a program for operating the magnifying observation apparatus the magnifying observation apparatus may be operated remotely from the computer 70. In the specification, the program for operating the magnifying observation apparatus using a computer includes an operation program installed in a general-purpose or dedicated computer externally connected to

the magnifying observation apparatus and an operation program incorporated into the information processor 50 as a controller of the magnifying observation apparatus. In the magnifying observation apparatus, an operation feature or operation program to operate the magnifying observation apparatus is previously incorporated. The operation program may be installed into the magnifying observation apparatus in the form of rewritable software or firmware or may be updated as required. Thus, in the specification, a computer to execute a program for operating the magnifying observation apparatus includes the magnifying observation apparatus itself.

[0045]

[Illumination conditions]

Observation conditions of the magnifying observation apparatus greatly depend on the illumination conditions. The illumination conditions are set with the observation condition settings screen in Fig. 5. The illumination conditions include control of the light quantity of a lamp as a light source. The light quantity is controlled by moving a slider sideways. A camera gain may be controlled as shown in Fig. 7. Image processing such as filter operation may be made on an observed image acquired as shown in Fig. 8. In these examples, automatic setting (Auto) or manual setting (Manual) is specified as a camera gain and ON or OFF of filter operation is selected.

[0046]

As well as by setting the illumination conditions,

photographing is also allowed by changing the angle of a camera 10 as imaging means. As shown in Fig. 9, it is possible to use an actuator 71 to make adjustable the orientation or angle of the camera 10, thereby grasping the observation subject at another angle.

[0047]

In this way, according to the embodiment of the invention, parameters for imaging an observation subject include various factors such as illumination conditions and angle of a camera. The user adjusts these factors to acquire a desired image. The control is made manually by the user although a beginner does not know which parameters are to be adjusted to acquire which image or which parameters are to be adjusted to obtain a desired image. Some skill and knowledge are required for the control which is no easy task. Thus, the magnifying observation apparatus according to this embodiment is equipped with a simple observed image acquisition means for acquisition feature for setting various observation conditions and automatically and simply acquiring a plurality of images for user's selection. The simple observed image acquisition feature automatically sets a plurality of observation conditions with parameters adjusted in various ways, acquires a magnified image simply or preliminarily under respective conditions, and lists a plurality of observation results for user's selection of a desired image.

[0048]

Fig. 10 shows an example of a simple observed image display 52B for displaying the results of execution of the simple observed

image acquisition feature. Fig. 10A shows a method for tiling the simple observed images 52b acquired. Fig. 10B shows a method for selectively displaying each of the simple observed images 52b. In either method, it is possible to display the simple observed images 52b side by side with an observed image display 52A as a main screen for displaying observed images 52a acquired. Or, the observed image display 52A and the simple observed image display 52B may be given in separate windows.

[0049]

In Fig. 10A, simple observed images 52b are displayed smaller than regular observed images 52b to tile a plurality of images. While not shown, simple observed thumbnail images 52b may be arranged in a tiling display and a selected image may be magnified in a preview display column. By displaying small the simple observed images 52b, it is possible to tile a plurality of simple observed images 52b, thus allowing easy comparison between the images. While six simple observed images 52b are acquired in the example of Fig. 10, the number of images is not limited to six but may be less than six, for example four, or more than six, for example more than seven. To display a larger number of simple observed images 52b, a large-capacity image memory to temporarily store images or a large video memory for screen display must be provided.

[0050]

As shown in Fig. 10B, the simple observed images 52b may be displayed selectively one at a time. Selection may use a mouse click



or toggling through button operation, or a slide show may be employed where display is switched automatically at predetermined periods. By displaying each image, it is possible to display each simple observed image 52b larger, approximately the same size as a regular observed image 52a, thereby allowing minute observation. Tiling in Fig. 10A and individual display in Fig. 10B may be alternately selected as desired by the user.

[0051]

In this way, by displaying acquired images in various methods, it is possible to select an image closest to the desired image while comparing the images with each other. By using this feature, the user need not know the setting items and parameters of the observation conditions. The user has only to compare the actual images with each other and visually select a desired image to know the appropriate observation conditions from the simple observation conditions set to the selected simple observed image. The observation conditions may be further adjusted as required to acquire an observed image anew. This allows a beginner to readily acquire a desired image.

[0052]

Next, a procedure to vary the observation conditions by way of the simple observed image acquisition feature to acquire a plurality of simple observed images will be described based on the flowchart in Fig. 11. In the example of Fig. 11, six simple observed images 1 through 6 are acquired and respectively stored into image memories 1 through 6. The image memory is an embodiment of simple observed

image storage means and can use the image data storage. A plurality of image memories may be provided in the image data storage or the storage area may be split into a plurality of subsections.

[0053]

Simple observation conditions for acquiring each simple observed image are combinations of observation conditions selectable on the illumination condition selection screen in Fig. 5. The simple observation conditions may be automatically set with the magnifying observation apparatus or arbitrarily specified by the user.

[0054]

In step S1, the image memory and illumination are initialized. At this point in time, the light source is not connected to the optical fiber and filters such as a diffuser 67 are all inserted. At this point in time, the user must have finished positioning and focusing on the observation subject on the observed image display 52A.

[0055]

Next, in steps S2 through S5, a simple observed image 1 to be recorded into an image memory 1 is acquired. In step S2, incident-light illumination is set. In step S3, a mask plate 63 is rotated to align the opening for peripheral illumination with the terminal of an optical fiber 61 for incident-light illumination. Then, in step S4, the diffuser 67 and the polarizer 68 are removed from the ring-shaped illumination so as to provide a transmitted light. In step S5, the simple observed image 1 is acquired under the aforementioned simple observation conditions, or more precisely,

incident-light illumination, peripheral illumination and transmitted light, and is recorded into the image memory 1.

[0056]

Next, a simple observed image 2 is acquired. The mask plate 63 is rotated so as to switch from the simple observation conditions set in steps 1 through 4, that is, incident-light illumination, peripheral illumination and transmitted light, to side illumination in step S6. Under the simple observation conditions, or incident-light illumination, side illumination and transmitted light, the simple observed image 2 is acquired and recorded into an image memory 2 in step S7.

[0057]

The simple observation conditions are varied the same way to sequentially acquire simple observed images 3 through 6 in the subsequent steps. In step S8, the diffuser 67 is inserted and the simple observation conditions including incident-light illumination, side illumination and diffuser 67 are set. Under these conditions, a simple observed image 3 is acquired. The simple observed image 3 is recorded into an image memory 3 in step S9. In step S10, the mask plate 63 is rotated to provide peripheral illumination. The simple observation conditions are set to incident-light illumination, peripheral illumination and diffuser 67. Under these conditions, a simple observed image 4 is acquired. The simple observed image 4 is recorded into an image memory 4 in step S11. In step S12, a polarizer 68 is inserted and the diffuser 67 is removed and the simple

observation conditions including incident-light illumination, peripheral illumination and polarizer 68 are set. Under these conditions, a simple observed image 5 is acquired. The simple observed image 5 is then recorded into an image memory in step S13. Finally in step S14, the mask plate 63 is rotated to provide side illumination. The simple observation conditions are set to incident-light illumination, side illumination and polarizer 68. Under these conditions, a simple observed image 6 is acquired. The simple observed image 6 is recorded into an image memory 6 in step S15.

[0058]

The simple observed images 1 through 6 acquired in this way are displayed on the simple observed image display 52B as shown in Fig. 10. As shown in the figure, only the simple observed images may be displayed or respective simple observation conditions may be displayed in text information. For example, an information display column may be provided as part of the screen to display the information on the simple observation conditions for the selected simple observed image. Or, with the simple observed images shown in Fig. 10A tiled, placing a mouse cursor on each simple observed image may display the simple observation conditions used when the simple observed image was acquired by way of tool tip display or balloon display.

[0059]

While the simple observation conditions for electrically reading a reflected light from the observation subject fixed to the

observation subject fixing section by way of incident-light illumination in the aforementioned embodiments, it is also possible to use simple observation conditions for electrically reading a transmitted light obtained by irradiating a light from behind an observation subject by using transmitting illumination. Similarly, it is also possible to add parameters to control the brightness of illumination as shown in Fig. 6, parameters to select Auto/Manual of a camera gain as shown in Fig. 7, and parameters to switch ON/OFF the filter operation as shown in Fig. 8. Further, it is also possible to add parameters to adjust the angle of the camera as shown in Fig. 9. Moreover, it is possible to specify the type of an observation subject to set corresponding adequate observation conditions.

[0060]

[Control of brightness of illumination]

Control of brightness of illumination is enabled by controlling a dimmer circuit by way of an information processor 50 or a computer 70. Means for controlling the brightness of an image include adjustment of the camera shutter speed, gain control, and control of the light quantity of a lamp. To observe a work vulnerable to halation, a lower light quantity of a lamp may lead to a better image.

[0061]

In case the brightness of an image is not completely controlled by way of control of the light quantity of a lamp and adjustment of the camera shutter speed, the camera gain is set to a higher value to make the image lighter. In ordinary observation, the brightness

of an image is controlled by adjusting the camera shutter speed. To obtain an optimum color representation by way of observation subject and observation conditions, control of white balance is also necessary.

[0062]

[Filter operation]

Filter operation is executed on an image to the conditions of a target image. For example, edge emphasis filter operation is made in order to sharpen the image.

[0063]

[Camera angle]

As shown in Fig. 9, it is possible to change the angle of a camera head by controlling an actuator 71 and photograph the observation subject at another angle. Through imaging at another camera angle, it is possible to obtain an image with different illumination.

[0064]

[Type of observation object]

It is possible to previously set appropriate observation conditions or simple observation conditions depending on the type of observation subject and call the optimum observation conditions by the user's selection of an observation subject. For example, observation of a metal is more vulnerable to halation. Through composite operation using two images shot at different shutter speed, it is possible to suppress halation. The composite operation is a

process whereby an image subject to halation is replaced with an image free from halation. Imaging at a higher shutter speed results in reduced halation. A combination of a plurality of pictures taken at different shutter speeds can produce an image without halation. Brightness of each image preferably undergoes preprocessing so as to make the seam inconspicuous, since the seam between two images without preprocessing will result in the conspicuous seam.

[0065]

In case the observation subject is a living thing, edge emphasis filtering is made. In case a mineral is observed, photographing in the monochrome mode is preferable. Further, the polarizer 68 is inserted before observation.

[0066]

[Advantage of the Invention]

As mentioned hereabove, magnifying observation apparatus, a method for operating the magnifying observation apparatus, a program for operating the magnifying observation apparatus, and a computer-readable recording medium of the invention provide an easy-to-use operation environment where the user can readily acquire a desired image without expert knowledge on the magnifying observation apparatus. This is because the magnifying observation apparatus, the method for operating the magnifying observation apparatus, the program for operating the magnifying observation apparatus, and the computer-readable recording medium of the invention automatically acquire a plurality of images under a plurality of observation

conditions in a simple fashion to allow selection of a desired image by the user and observation under the selected conditions. In general, setting of observation conditions is not easy for a beginner. With this invention, a plurality of simple observed images are tiled to allow selection of a desired image by the user. This lets the user visually select the target image so that it is easy to select appropriate setting conditions and a beginner not familiar with the operation of magnifying observation apparatus can advantageously use the magnifying observation apparatus of the invention intuitively.

[Brief Description of the Drawings]

Fig. 1 is a general view of the magnifying observation apparatus according to an embodiment of the invention;

Fig. 2 is a block diagram of the magnifying observation apparatus according to an embodiment of the invention;

Fig. 3 is a general view of a mask plate of the magnifying observation apparatus according to an embodiment of the invention;

Fig. 4 is a conceptual drawing of an example of various illumination methods;

Fig. 5 is an image drawing of an example of the user interface screen of the illumination condition selection screen in a program for operating the magnifying observation apparatus;

Fig. 6 is an image drawing of another example of the user interface screen of the illumination condition selection screen in a program for operating the magnifying observation apparatus;



Fig. 7 is an image drawing of another example of the user interface screen of the illumination condition selection screen in a program for operating the magnifying observation apparatus;

Fig. 8 is an image drawing of another example of the user interface screen of the illumination condition selection screen in a program for operating the magnifying observation apparatus;

Fig. 9 is a general view of an actuator for adjusting the angle of a camera;

Fig. 10 is an image drawing of an example of the simple observed image display; and

Fig. 11 is a flowchart showing a procedure to acquire a simple observed image by way of a simple observed image acquisition feature.

[Description of the Reference Numerals and Signs]

10: Camera

11: Optical system

12: CCD

13: CCD controller

20: Stage elevator

21: Stepping motor

22: Motor controller

30: Stage

41: Stand

42: Support

43: Camera attaching section

50: Information processor

51: Controller

52: Display

52A: Observed image display

52B: simple observed image display

52a: Observed image

52b: Simple observed image

53: Memory

54: Interface

55: Operation section

55a: Pointing device

60: Illumination section

60A: Incident-light illumination

60B: Transmitting illumination

61: Optical fiber

62: Connector

63: Mask plate

64: Rotary axis

65: Opening

65A: Opening for peripheral illumination

65B: Opening for side illumination

66: Motor

67: Diffuser

68: Polarizer

70: Computer

71: Actuator

S: Sample

[Abstract]

[Problem]

Providing a feature to guide the operation procedure so that even a person not familiar with the operation of magnifying observation apparatus can operate the apparatus

[Means for Resolution]

The magnifying observation apparatus comprises imaging means for photographing an observed image and display means for displaying the observed image based on a signal acquired with the imaging means, the magnifying observation apparatus further comprising: simple observation condition setting means for setting simple observation conditions for simply acquiring a plurality of observed images; simple observed image display means for displaying a plurality of simple observed images acquired per the plurality of simple observation conditions set with the simple observation condition setting means; selection means for selecting a desired simple observed image from among the plurality of simple observed images displayed on the simple observed image display means; observation condition setting means for setting further observation conditions as required based on the simple observation conditions set to the simple observed image selected with the selection means; and observed image display means for displaying an observed image acquired based on the observation conditions set with the observation condition setting means.

[Selected Drawing]

Fig. 3



FIG. 1

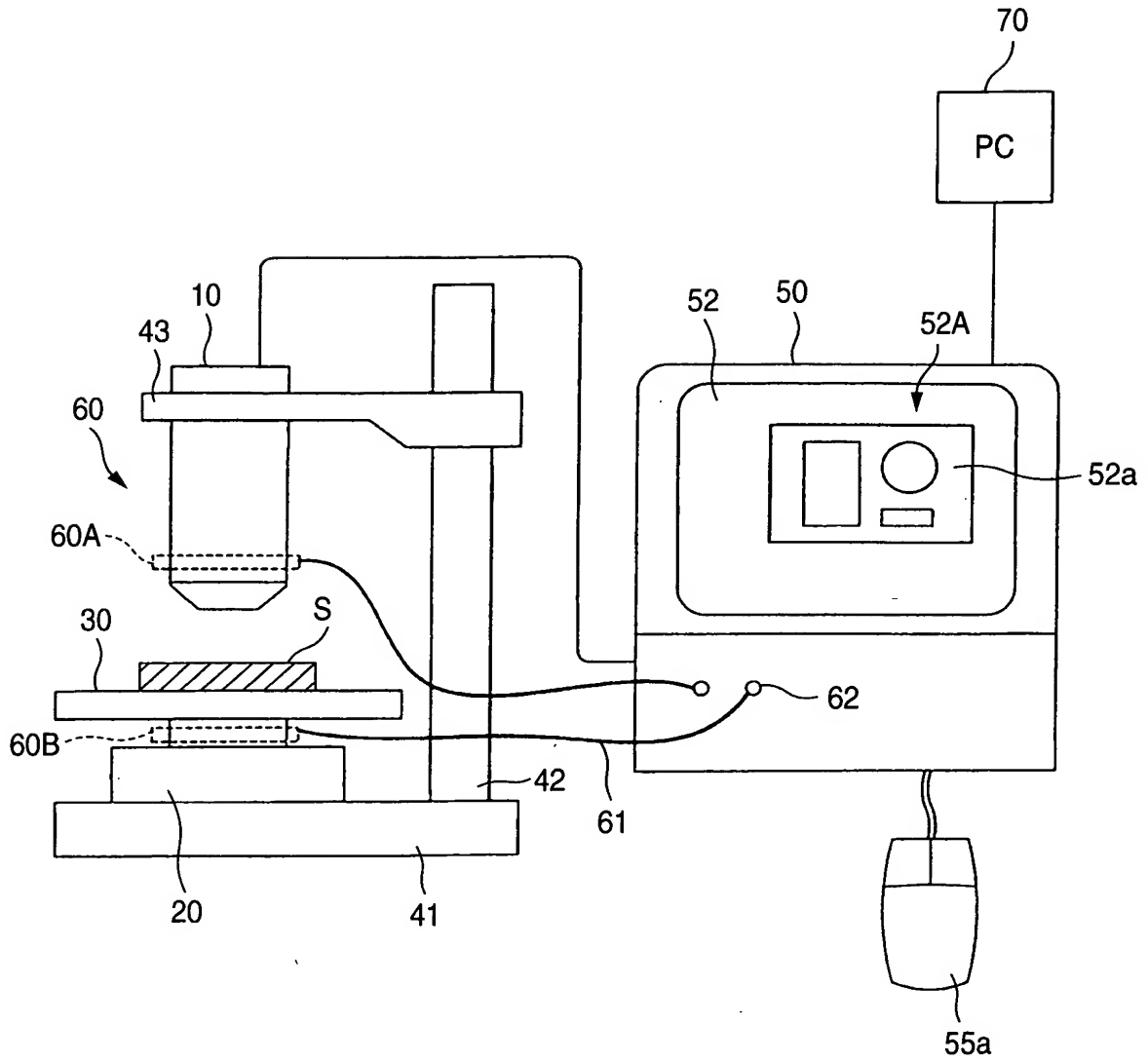


FIG. 2

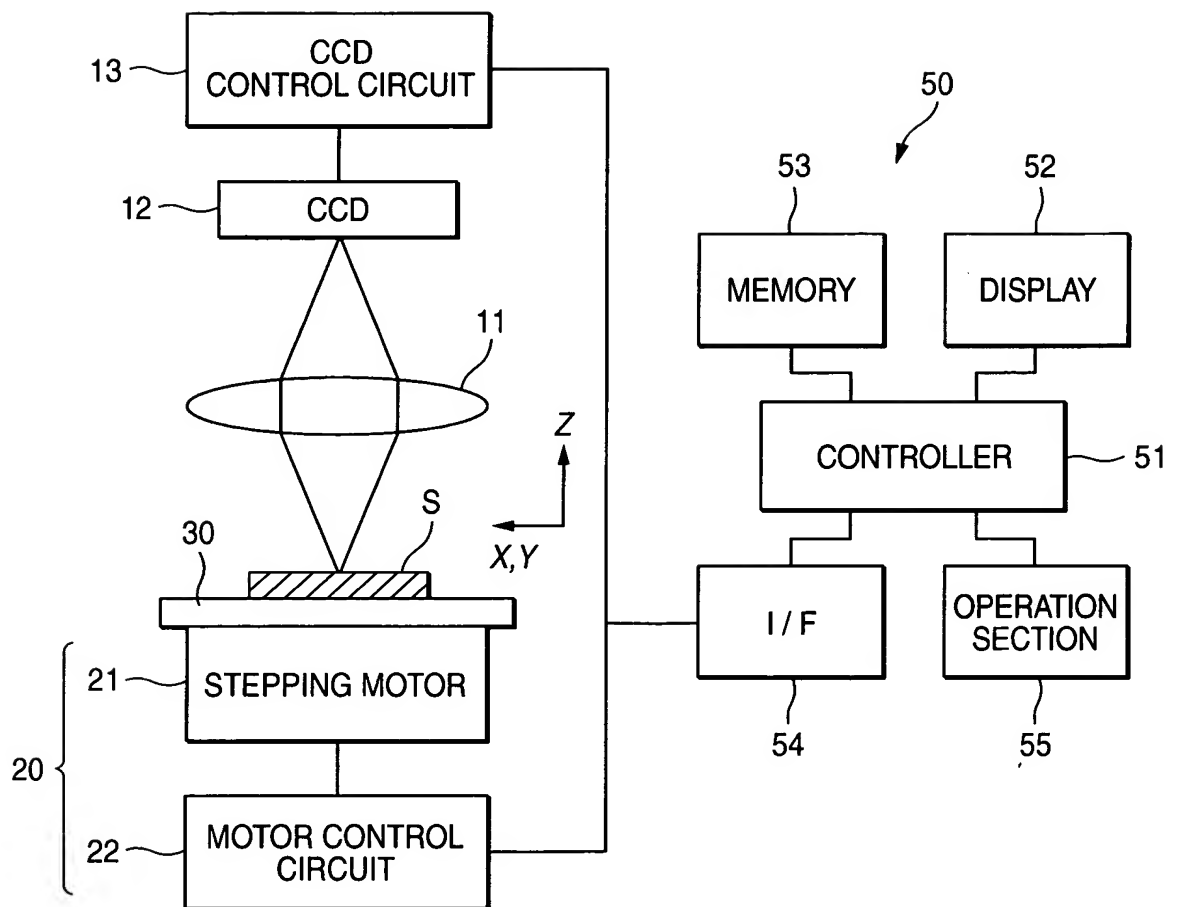


FIG. 3A

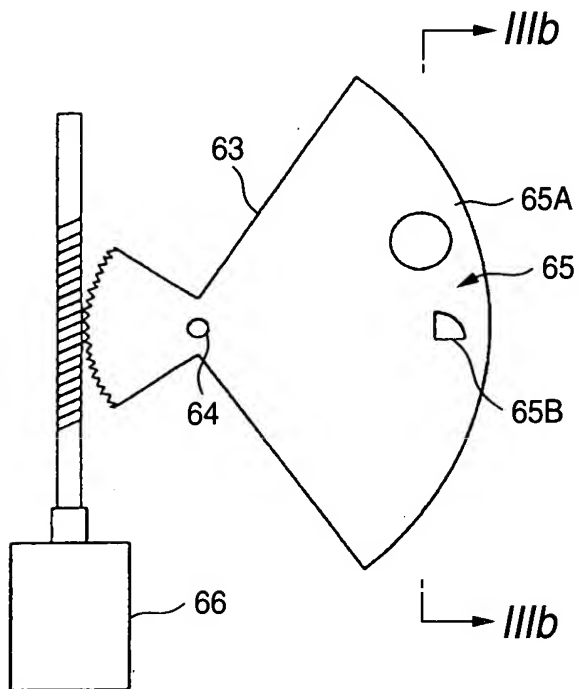
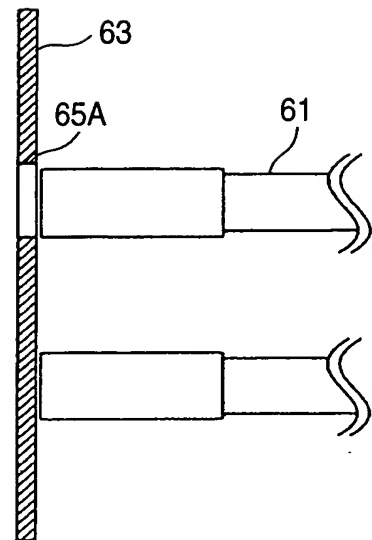
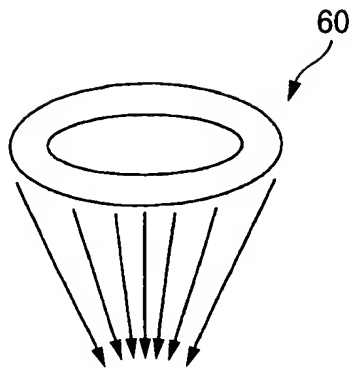


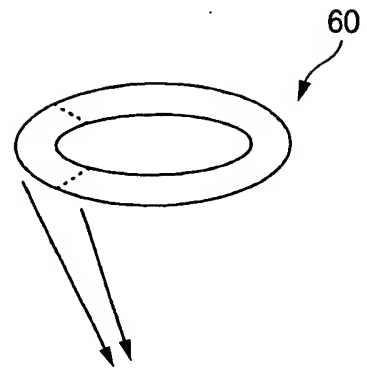
FIG. 3B



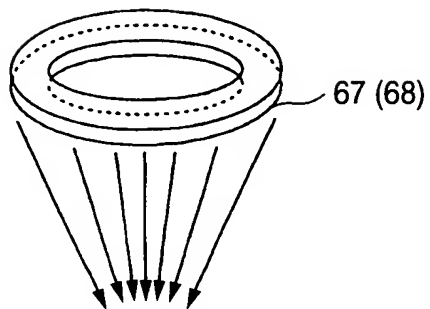
*FIG. 4A*



*FIG. 4B*



*FIG. 4C*



*FIG. 4D*

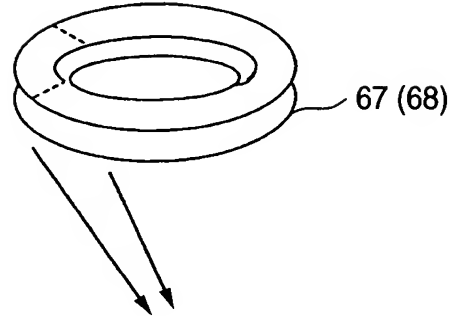
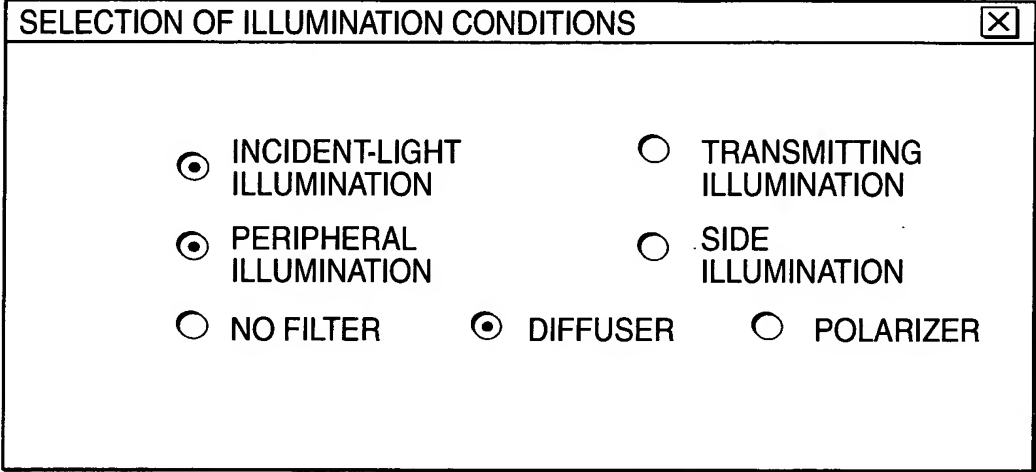




FIG. 5

52



SELECTION OF ILLUMINATION CONDITIONS

☒ INCIDENT-LIGHT ILLUMINATION

☒ PERIPHERAL ILLUMINATION

☐ NO FILTER

☐ TRANSMITTING ILLUMINATION

☐ SIDE ILLUMINATION

☐ POLARIZER

☒ DIFFUSER

FIG. 6

52

SELECTION OF ILLUMINATION CONDITIONS

☒ INCIDENT-LIGHT ILLUMINATION      ☐ TRANSMITTING ILLUMINATION

☒ PERIPHERAL ILLUMINATION      ☐ SIDE ILLUMINATION

☐ NO FILTER      ☒ DIFFUSER      ☐ POLARIZER

LIGHT QUANTITY OF LAMP

A horizontal slider bar with five vertical tick marks. A small rectangular slider knob is positioned between the second and third tick marks from the left.

FIG. 7

52

SELECTION OF ILLUMINATION CONDITIONS

☒ INCIDENT-LIGHT ILLUMINATION ☐ TRANSMITTING ILLUMINATION

☒ PERIPHERAL ILLUMINATION ☐ SIDE ILLUMINATION

☐ NO FILTER ☒ DIFFUSER ☐ POLARIZER

LIGHT QUANTITY OF LAMP

CAMERA GAIN

☒ AUTO ☐ MANUAL

FIG. 8

52

SELECTION OF ILLUMINATION CONDITIONS

☒ INCIDENT-LIGHT ILLUMINATION      ☐ TRANSMITTING ILLUMINATION

☒ PERIPHERAL ILLUMINATION      ☐ SIDE ILLUMINATION

☐ NO FILTER      ☒ DIFFUSER      ☐ POLARIZER

LIGHT QUANTITY OF LAMP

—————|—————|—————|—————|—————|

CAMERA GAIN

☒ AUTO      ☐ MANUAL

FILTER OPERATION

☒ ON      ☐ OFF

**FIG. 9**

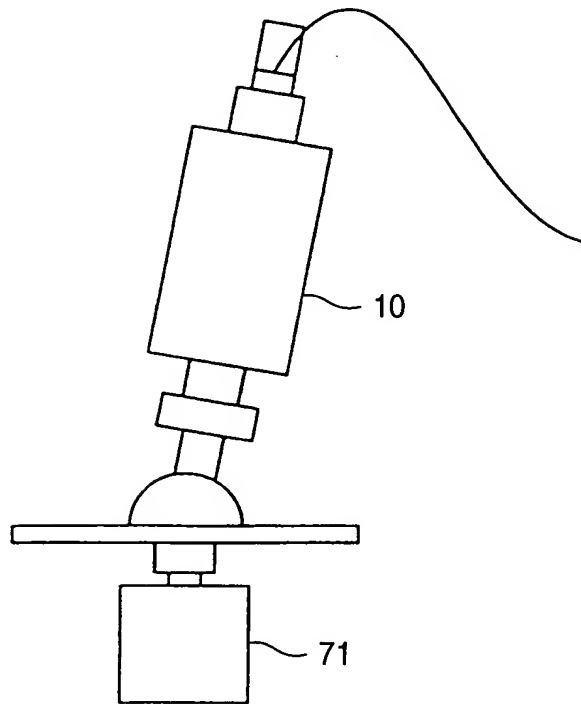


FIG. 10A

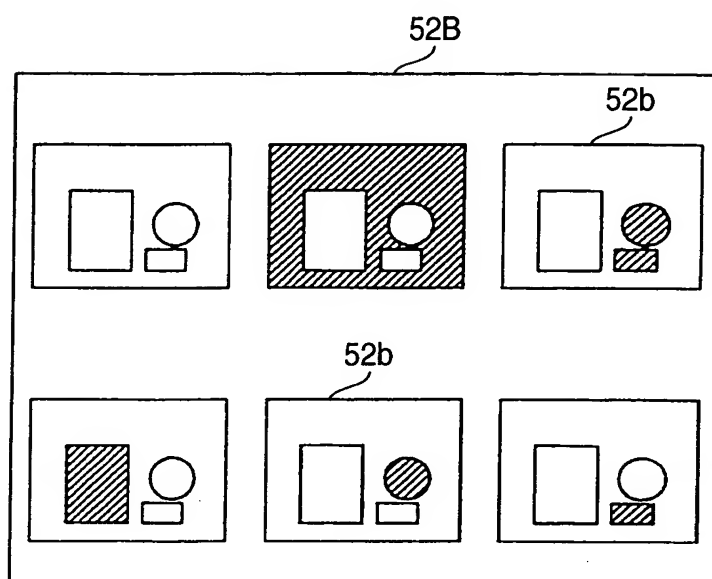


FIG. 10B

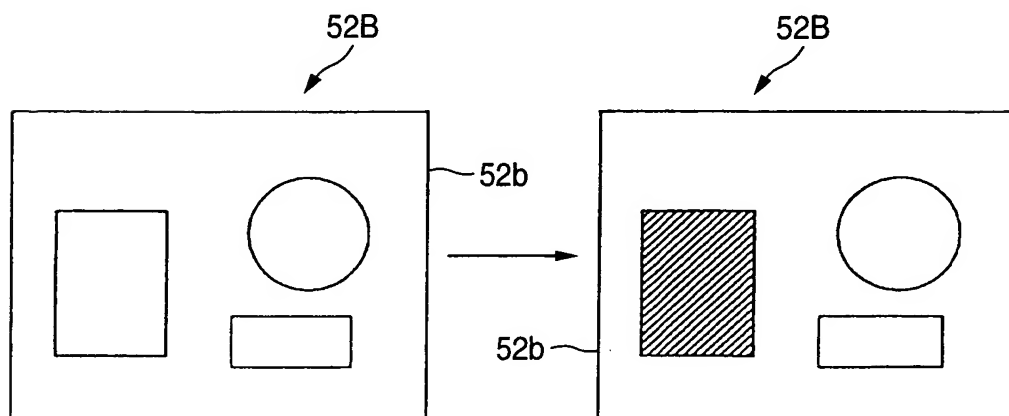


FIG. 11

